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ASTRONOMY, PHYSICS, AND PHILOSOPHY

By A. VIBERT DOUGLAS

(THE ADDRESS OF THE RETIRING PRESIDENT OF THE ROYAL ASTRONOMICAL SOCIETY OF CANADA)

I

IN the search for knowledge, whether it be knowledge of the physical world close around us or of the vast universe external to the earth or whether it be knowledge in the realm of philosophy and human conduct, the starting point is faith and the first step is frequently taken by the guidance of intuition. Then reason carries on, working inductively upon the facts of observation and experiment and deductively from the resulting generalizations, hypotheses and theories to point out crucial tests and observations. In the light of the results of these crucial tests, the generalizations must then be reconsidered. Thus the scientific method gets underway and whither it leads the honest seeker after truth must follow. "Trust in reason," wrote Dean Inge voicing in this age the thinking of Clement of Alexandria in the sixth century, "in reason which rests ultimately upon faith in the Divine Logos, the self revealing soul of the Universe." "In the age of reason," says Sir Arthur Eddington, "faith yet remains supreme; for reason is one of the articles of faith."

This basic and fundamental position of faith in the realm of ethics and the moral law is said to be the main thought behind Dostoevski's great novel, *Crime and Punishment*. In a recent article by E. M. Dodd on this subject, it is stated that recognition of Moral

Law "is not an act of Reason in the sense of intellection . . . Reason cannot exalt Altruism into an obligation nor establish the idea of the sanctity of human life; these perceptions are the reward of Faith, and it is in virtue of them alone that Reason is relevant to human life at all." Whether or not we are convinced that this is true of all men, we may probably agree with the late Poet Laureate when he writes "Verily by Beauty it is that we come at Wisdom yet not by Reason at Beauty."

In the realm of science we find the basic rôle of faith enunciated thus by A. N. Whitehead: "Faith in reason is trust that the ultimate natures of things lie together in harmony which defies mere arbitrariness." It is this faith in the order of Nature that has sustained men of science in their search for truth in spite of all difficulties, false clues, shattered theories and apparent failures; it has led them to defy discouragement and to erect through the centuries the stately edifice of science which we know today, an edifice that is growing before our eyes and will continue to grow as long as thinking man inhabits the earth.

Man's reliance upon an intuitive leading is no less certain here than in the realm of philosophy. Three of the greatest mathematicians of our time have borne testimony to this fact. Describing his attempt to derive from "world-geometry" not only gravitational phenomena, as in the pioneer work of Einstein, but also the full range of electromagnetic phenomena, Weyl says that in order "to bring about the transition from affine to metrical geometry we must once more draw from the fountain of intuition." Similarly, Lemaitre, referring to one particular line of reasoning at the outset to his theory of an expanding universe, writes that "this method provides a very intuitional way of considering the equations of the universe." Eddington has written as follows: "In science we sometimes have convictions as to the right solution of a problem which we cherish but cannot justify; we are influenced by some innate sense of the fitness of things."

We should not forget however that though intuition may suggest a starting point it must never be thought of as providing a resting place. It is reason that must take this wisp of intuitive thought and examine it, test it, stretch it, weave it, harness it. Thus in their

fundamental approach to the furtherance of knowledge we see that philosophy, physics and astronomy have much in common. It is equally true that there have been strong mutual influences exerted by each on the others as knowledge grew in these fields.

II

Within the interlocking fields of mathematics, physics and astronomy, the influences have been continuous and sometimes spectacular. Both physics and astronomy depend upon mathematics as a tool. The investigations into conic sections by Appolonius of Perga and other early geometers were ready to hand when Kepler, many centuries later, sought out his empirical laws of planetary motion. When Newton subsequently established their theoretical validity in terms of the inverse square law of gravitation, and when he investigated the trajectories of projectiles, it was this geometry that he found to be applicable. When he encountered certain fundamental problems in mechanics and stellar dynamics and discovered his mathematical tools to be inadequate, Newton invented fluxions. Other problems remained unsolved until Sir William Rowan Hamilton invented quaternions.

The investigations into non-Euclidean geometry by Gauss, Lobatchevsky and Riemann and the developments of tensor calculus by Ricci, Levi-Civita and Christoffel had produced mathematical tools which it was the genius of Einstein to recognize as best suited in the representation of physical phenomena. Einstein's pioneer work led to the cosmological researches of de Sitter, Weyl, Eddington, Lemaitre, and subsequently of Milne, Schroedinger and Saxby.

When atomic physics and spectroscopy were faced with problems and difficulties which appeared insoluble, de Broglie initiated a new era with wave mechanics. New mathematical forms had to be invented, hence Dirac's wave-tensor calculus. Physics found new applications for determinants and theory of groups. So, too, in astronomy it was when the investigation of stellar structure was seen to involve Emden's equation that R. H. Fowler turned his attention to this problem and obtained a complete classification of all solutions of this important second-order differential equation, a permanent and beautiful contribution to pure mathematics. We need not labour

this point: obviously Supply and Demand or Demand and Supply are operative principles in this realm of intellectual effort, and whether it be competitive or cooperative at the outset the result is always ultimately and cumulatively beneficial to all future investigators in these fields.

III

The close association between physics and astronomy can best be illustrated by means of a parable.—Two young investigators filled with the curiosity, imagination and faith of the scientists, came to Dame Nature and said: We wish to give our lives to scientific research, what shall we do? To one Dame Nature replied, Take thou the atom. To the other she said, Take thou the star. Perhaps you think, as they did, that their paths would never cross, the one in his laboratory delving into the profundities of things so small that no microscope will reveal them, the other in his observatory photographing a distant galaxy of many thousand million stars. You can imagine that each might become discontented with his lot, and, with that strange perversity of human nature, the one may return to Dame Nature and say: You told me to study atoms, but I should like to study stars! And the other may come back and say: You told me to study stars, but I want to study atoms! And Dame Nature will smile quietly as she replies: Yes, I told you to study the atom; return to your laboratory, bend all your energy to the task and some day you will find that the walls of your laboratory are expanding and expanding until they include—the stars. To the other she will make answer: Yes, it is true that I told you to study stars; return to your telescope, your spectrograph and your measuring instruments and lo! very soon you will discover that you are really studying atoms. This is not merely a parable, it is the actual truth.

In the light from the limb of the sun observed just before and after totality at the eclipse of 1868, an intense yellow ray was noted to which the astronomers could give no identification. The unknown atom was given the name helium because of its solar origin. Here was a challenge to the physicists and chemists, but not until 1895 did Ramsay, the chemist, find this element in the earth's atmosphere; not until some ten years later did Rutherford, the physicist, find by

spectroscopy that the alpha particle, one product of radio active disintegration, is the nucleus of a helium atom; and not until the years of the first Great War was helium found in natural gas from certain wells.

Physics has been hampered in its efforts to determine the properties of matter by the existing limitations of terrestrial laboratories. How matter behaves at extremely low temperatures was not known until the development of cryogenic laboratories first at Leyden, and afterwards at Toronto and elsewhere. In high temperature investigations, the limit was until relatively recently the crater of the arc in an electric furnace—a region whose temperature just overlapped that at the radiating surface of the cooler stars. This is where astrophysics took up the investigation and observed the behaviour of matter at successively higher and higher temperature.

Today in terrestrial laboratories it is possible to obtain temperatures up to 6,400°C. with a specially controlled tungsten arc and experiments with exploding wires under high potential indicate peak temperatures of between 19,000°C. and 20,000°C. In the photospheres of stars of classes G to B the astroyphysicist has sources of continuous radiation from matter at these temperatures. The central stars of some planetary nebulae have surface temperatures which may be as high as 100,000°C. This estimate is based upon the fact that a lesser temperature would not permit of radiations which can produce in the surrounding nebulous gases high ionization such as thrice ionized oxygen. Beyond this we may not go by direct observation but astronomers have calculated the temperatures in the deep interiors of stars as exceeding 10^7 degrees. This has been done by mathematical investigation of the equilibrium conditions from photosphere to centre checking results by the observed output of energy. If the central temperature of a star be postulated too high, the liberation of energy would be so great as to blow off the surface layers by the violence of radiation pressure. On the other hand too low a central temperature would result in a general collapse of the gases forming the outer layers under gravitational forces unbalanced by sufficient gas and radiation pressure. Sir Arthur Eddington was a pioneer in this work.

A new era in spectroscopic research began when Sir William Crookes developed low pressure discharge tubes. A good vacuum today is one in which the gas pressure is reduced to about 10^{-6} mm. Hg. This is the pressure high up in the solar chromosphere as studied in the flash spectrum. The lowest pressure attainable in the laboratory is said to be about 10^{-9} mm. Hg. Even here there are still 10^{7} molecules per cc. The least dense star known to astronomy is the large infra red component of the binary system 7_{ϵ} Aurigae. Its density is 10^{-9} gms/cc. for though it is a massive star, its radius is three thousand times that of the sun. The solar system out to Saturn's orbit could all lie inside this star. Its substance is so tenuous that it would be transparent were it not for the partial opacity, the "Heaviside effect", due to ionization produced by the radiation from its hot bright smaller companion. In interstellar space we have matter at a temperature of about 4° Absolute, so attenuated that there is only an average of one atom in each cubic centimetre. To get a real idea of what this approach to emptiness signifies, it is necessary to remind ourselves that in a cubic centimetre of air at standard temperature and pressure there are 2.7×10^{19} molecules. The presence of interstellar lines in the spectra of distant stars reveals the behaviour in interstellar space of calcium, sodium, hydrogen, potassium, iron and ionized calcium, nitrogen, oxygen and titanium as well as the molecules CN, CH and CH^{+}. From this evidence conclusions may be drawn as to the behaviour of other atoms and molecules under analogous physical conditions.

At the other extreme, that of very high density, the physicist is limited by his inability to compress matter much beyond the natural density of the densest element, osmium 22.5 gms. per cc. The most powerful hydraulic press will not compress this by more than a small fraction. But here again the stars provide extreme conditions far exceeding those of the terrestrial laboratory. In the white dwarf stars the properties of matter at densities of 30,000 and more can be studied. In this new field for theoretical investigation R. H. Fowler showed that the statistical mechanics of degenerate gases explained the behaviour of these stars.

Yet another striking example of the interlocking of physics and astronomy is to be found in the developments of nuclear physics where experiment and theory led to the postulate of a new fundamental

particle—the neutrino. Having the mass of an electron or a few multiples of this, escaping direct detection because electrically neutral, its existence is none the less a legitimate hypothesis because by no other hypothesis have the energy relations of certain known nuclear changes been balanced. The principle of conservation of energy appears to demand the existence of neutrinos. In astronomy there arose a new problem of universal significance with the realization that a supernova was a cataclysm of nature whose magnitude vastly exceeded that of an ordinary nova. To explain this catastrophic liberation of energy, Gamov has called in the assistance of the minute neutrinos. He has suggested that a very massive star may increase in central temperature to 10^9 degrees while the usual sources of stellar energy are operating, but at this point new nuclear reactions begin and neutrinos may be liberated in great numbers. These neutrinos carry off much of the gravitational energy of the star which will collapse with such suddenness that vast amounts of energy-producing gases are hurled outward. The result is the unrivalled phenomenon of a supernova.

Astrophysics is a subject bristling with unsolved problems, and with exciting hypotheses. Progress will not be due to physics alone nor to astronomy alone, but to that happy combination of both these sciences in their observational, experimental and theoretical aspects. Such a combination will achieve its highest expression in a mind of creative capacity and holistic quality capable of framing "out of three sounds . . . not a fourth sound, but a star."

IV

The influence of astronomy upon philosophy, including religious thought, is not a subject that can be briefly and categorically stated for it offers an outstanding example of the truth contained in the old maxim *Quot homines tot sententiae* or, in modern phraseology, the same stimuli may produce very different reactions in different individuals. "The ancient world," wrote Whitehead in 1925, "takes its stand upon the drama of the universe, the modern world upon the inward drama of the soul." Today many people would substitute for the soul the words society and the individual, believing that sociology, biology and psychology are now the dominating influences

upon philosophy. Yet it is still very true that the inward drama of the soul and the dramas of the mind and of mankind are often profoundly influenced by the drama of the physical world where the actors are radiations, electrons, atoms and stars.

In the ancient world with its geocentric cosmology it was natural for very great importance to be attached to man. For him the sun and moon were created to give light upon the earth, for him the stars marched nightly across the sky, for him the seasons brought seed-time and harvest, for his sins the earth was visited by drought or quake or pestilence. The importance of man in the scheme of creation was sung by the Psalmist—What is man that Thou are mindful of him . . . Thou hast made him a little lower than the angels and hast crowned him with glory and honour . . . Thou hast put all things under his feet." Shakespeare had caught this spirit when he wrote his famous "What a piece of work is man! how noble in reason! how infinite in faculty! . . . in action how like an angel! in apprehension how like a god!"

When the Copernican cosmology replaced the Ptolemaic, the importance of man became no longer an obvious deduction from a survey of the physical world, and an assertion of his intrinsic importance had to be supported by arguments based solely on his intellectual or spiritual worth. This has been the case ever since. To some types of minds in whatever age the spiritual reasons always outweighed the purely physical, but there are other people to whom it comes as a great shock that man appears to be but an accidental development in very recent ages upon this little old earth, a minor planet, revolving about one quite ordinary dwarf star whose position is somewhere far out from the centre of one of the many millions of galaxies of stars. To minds of this type the Copernican cosmology represents a major upheaval of what had become traditional thought. Astronomy thereafter pictured man as a mere speck in the immensity of space, and a late-comer in time. Then geology joined forces with astronomy to measure out time by era upon era, so that the average span of a human life is to the estimated age of the earth as one minute of time to three score years and ten. Biology added to the mental upheaval by appearing to present a rigidly mechanistic view of life —the great conceptions of evolution, of natural selection, the dis-

coveries of physiological and psychological sciences being swallowed, unmasticated and often misunderstood, by a hungry or a gullible multitude. Bishop Gore thought the effect of all these ideas upon the religious imagination, could hardly be exaggerated:- "They seemed as represented in popular literature almost to obliterate God, behind a self developing universe, and to reduce the position of man to insignificance." In our own day the great challenge is once more coming from astronomy, according to Bishop Headlam. The great popularity of various non-technical books dealing with the recent discoveries in astronomy, astrophysics and atomic physics has brought thousands of people face to face with some of these facts for the first time; and they are mentally and spiritually staggered by the immensities of time and space, and by what seems to them the grandeur or the grimness of inexorable law. It is worth noting that it is the readers rather than the authors who react in this manner. The average reader will frequently draw extreme conclusions and be swayed into adopting an essentially illogical attitude of mind very far from the position which the author himself holds and intended to convey.

It is strange that men are so easily appalled by large numbers—but it is none the less certain that this is a very usual reaction. One blade of grass is intrinsically quite as wonderful as a thousand blades of grass, and ten thousand million stars are no more wonderful than is one star, yet man is overawed by mere number. We see this in Shelley, for whom "the plurality of worlds—the infinite immensity of the universe is a most awful subject of contemplation. He who rightly feels its mystery and grandeur is in no danger . . . of deifying the principle of the universe." Yet the men who actually count the stars, measure their distance, and time their revolutions are very rarely the men who deny God, the Creator of the universe. Contemplating the evidence for cause and effect—the reign of law—in the physical universe, Shelley exclaims, "Necessity! thou mother of the world!" and in his footnote he draws this conclusion "The doctrine of Necessity tends . . . utterly to destroy religion."

A few years before Shelley had written these negations in footnotes to *Queen Mab,* the very same astronomical discoveries and the great achievements of Newton were influencing the thoughts of

Immanuel Kant; but very different were his reactions. The grandeur of a planetary world, the Milky Way, the nebulae, super-systems of stars—"the infinite field of Creation—the work of God—the great Builder of the universe—We see the first members of a progressive relationship of worlds and systems—an abyss of real immensity in presence of which all the capability of human conception sinks exhausted, although it is supported by the science of number. The wisdom, the goodness, the power which have been revealed are infinite." Kant's affirmation is well known that two things moved him to reverence—the starry heavens without and the moral law within.

In Pascal we see a philosopher overwhelmed equally by the vastness of the visible world, which is itself but "an imperceptible speck in the ample bosom of nature" and by the abyss within the smallest conceivable particle of matter. Between these two extremes, he stands silent. For him there is no easy acceptance of a God revealed by Nature—a reign of Law, yes; the sublime triumphs of mathematical expression of natural law in the outer universe were in progress. Copernicus, Bruno, Kepler, Galileo, Bacon, Descartes, these were the influences so potent upon thought in the 17th Century, and on Pascal and Spinoza these influences made deep impression. But while the former turns from the outer world of nature to seek God in the spirit of man, the latter finds Him "the immanent cause of all things. . . . From the infinite nature of God, all things follow by necessity."

Given a completely random assemblage of all the energy of the stellar system, what is the probability of the present state of organization having come about by pure chance? This is the question asked and answered by Sir James Jeans whose calculation showed that the probability was so incomprehensibly small as to indicate rather impressively the logical need for a Creator, a Great Architect of the universe. Bruno arrived at a similar conclusion without climbing up a ladder of mathematical reasoning—"For things have not come about by mere accident, but through the determining mind." Whitehead likewise reaches this conclusion by no devious path—"The order of the world is no accident—the religious insight is the grasp of this truth."

There is a class of public speakers and writers who misunder-

stand and misuse modern scientific thought in an effort to obtain oratorical effect or to bring into sharp relief the contrast between the physical and the moral order. A stock phrase is that the physical universe is "a soulless repetitive mechanism." The picture conjured up before the mind is of stars and planets endlessly circling about their appointed orbits for ever and ever and a day—a picture of futility and changelessness; and against this mechanistic principle of nature the spirit of man is urged to fight. This conception is contrary to the true astronomical and physical picture, and much loose thinking is woven about it.

No one can ponder upon the solar system, upon the great multiple star systems, or upon the beautiful photographs of the spiral galaxies, and argue that this is a static universe. It is obviously a dynamic universe; but it is not the arena of haphazard change nor of mere repetition—it is a dynamic universe of directed change. All the change that goes on in the physical universe is towards unavailability of energy; "physically wasting but spiritually ascending," to quote the comment of Professor Whitehead who in those five words reveals himself as both physicist and philosopher. Thinking not only of cosmological changes but also of the geological and biological changes which the centuries and eras reveal, Herbert Spencer framed his evolution-formula, postulating that development in all things proceeds from a state of "indefinite unstable homogeneity" towards a "definite stable heterogeneity." It is important to note that in this famous metaphysical speculation there is no suggestion of mere repetition.

V

The dynamic phrase, The Prime Mover, is one of Aristotle's great contributions to metaphysical thought. The Greek philosophers were steeped in the astronomical knowledge of their day, and cosmological speculation flourished in their midst. Asked what was the chief object of being born into this world, Anaxagoras replied—To investigate the sun, moon and heavens. And Plato impressed upon his students that theirs was the high task of finding "what are the uniform and ordered movements by assuming which the motions of the planets can be explained." That the sun, moon, planets and stars

moved, and moved in obedience to some law, was an observation of tremendous significance to the Greek philosophers. When Aristotle sought to complete his Metaphysics, he was driven inevitably and inexorably by the force of dispassionate logic to postulate the great Prime Mover. The significance of this can scarcely be overemphasized. It has influenced much philosophic thought down to the present day. It is one of the strong influences playing upon the mind of Whitehead when he undertakes the difficult task of restating a metaphysics in terms of modern language in the light of modern knowledge. With the passing of the very limited and artificial cosmology of the Greeks, the metaphysical need of God as the Prime Mover has disappeared. Motion, in the thought of the natural philosopher of the 20th Century is simply one of the many forms of energy. But an analogous metaphysical need does arise, and Whitehead is led to the conclusion that "the general character of things requires that there be such an entity. . . . God as the Principle of Concretion."

The sport of sports to the master cosmological thinkers during the past twenty years, has been to devise mathematical equations representing various geometries of space and time; equations from which would arise, or within which are embedded, so to speak, as identities the mathematical representations of the laws of nature as the astronomer and as the physicist sees them. This means that the so called laws of nature are not edicts imposed from without—the law of gravitation for example, is not what it is because the Prime Mover propels the planets around certain orbits with certain velocities. The laws of nature are what they are because the universe including the mind of man is what it is—a sentence that is inspired by Whitehead's remark that "the electron does what it does because it is what it is," which saying can be glibly made, but carries a meaning not entirely on the surface.

Now each one of these proposed cosmological equations may represent a theoretically possible universe and there may well be an infinity of such possibilities, but no one of the entries (whether of Einstein, or de Sitter, or Lemaître or other) has won the blue ribbon, because no one of their equations truly and completely represents the actual universe. Furthermore even if such an equation be formulated,

this fact still remains obvious that this equation is only one of the many representing theoretically possible universes. "We conceive actuality as in essential relation to unfathomable possibility." (Whitehead)

The prime command and its result, are set forth in the Book of Genesis with stately simplicity—"And God said, Let there be light, and there *was* light"—not any kind of light, with any of the many different properties one might imagine that light could conceivably display; but the particular kind of light that plays so basic a part in our physical experience, the light whose properties are so beautifully set forth in the Maxwellian equations and quantum laws. "Every actual occasion is a limitation imposed on possibility," to quote again from the author of the phrase, the Principle of Concretion, "God is the ultimate limitation—God is not concrete, but he is the ground for concrete actuality."

Two of the baffling mysteries which challenge the mind of the philosopher are space and time. Into what category is he to put them and how define them? Newton, Leibnitz and Kant strove to clarify these terms. Newton took them for granted as things-in-themselves, —eternal, infinite, self-subsisting—a point of view that drew fire from Kant. Leibnitz classified them as ordinary concepts, to which Kant raised the objection that ordinary concepts have instances, whereas there is but one space and one time. Kant regarded space and time as the forms of perception, external and internal, respectively; in no sense things-in-themselves, yet not illusions; transcendentally ideal, but empirically real. While this critical sifting of words and ideas went on and on, the absolute Euclidean space, and "absolute, true and mathematical time" accepted explicitly by Newton, provided the frame-work within which the Newtonian celestial mechanics functioned with spectacular success for nearly two hundred years. Then the triumphant chorus of astronomical approval of absolute space and time began to falter. The motion of the perihelion of Mercury's orbit refused to conform to Newtonian calculations. Physics likewise provided food for thought—the earth's motion relative to the ether could not be detected, and the apparent mass of an electron was found to be a function of its velocity.

Einstein's Theory of Relativity swept absolute space and absolute time from the astronomical, the physical and the philosophical horizons. Three out of four crucial tests of this theory were astronomical; and it is the astronomers, naturally, who are providing the observational data that is hurling out the frontiers of explored space to almost inconceivable distances. The velocity of light being finite, the astronomer is looking backward in time as he looks outward in space. How far he is justified in interpreting what he sees in the stellar universe in terms of physical laws established in a "Here-Now" environment is a question upon which it is not wise to be dogmatic. P. W. Bridgman has warned that such a procedure applied at the limits of the astronomical time scale is a "hair raising extrapolation"! Into the thoughts of many cosmologists has come the idea that what appear to us as laws of nature are relationships between phenomena which are the result of the sum total of physical conditions as they now are, and of the selection from this sum total which is made by the mind of the natural philosopher, a selection largely dictated by the mind's own limitations. Eddington has stressed this latter part, the subjectivity of the laws, while repudiating the former part on epistemological grounds. He has said, "The constants of nature (apart from our arbitrary units) are numbers introduced by our subjective outlook, whose values can be calculated *a priori* and stand for all time."

Philosophy attempts to survey all knowledge and fit the significant principles of all departments of knowledge into a coherent whole. When Heisenberg's Principle of Uncertainty was enunciated in 1927 it very soon became grist for the philosophers' mill. Some refused to accept this indeterminism as intrinsic in the universe, attributing the uncertainty in position and momentum of a particle to man's inability to observe and measure with sufficient accuracy or to an inadequate formulation of the concepts of physics; quite failing to grasp the significance of the fact that the products of these two uncertainties is a constant. The law of causality has dropped completely out of physical science in the sense that the present system of fundamental laws can deal with probabilities but cannot predict the future of the universe. This is a fact not yet fully assimilated by philosophy. Some amateur philosophers have taken the fact of indeterminism

as an argument for freedom of will in the individual—a misuse of ideas relevant to the realm of physical science which is wholly to be deprecated.

Twenty-five years ago natural philosophers and metaphysicians faced what appeared to be a deep gulf fixed between atomicity and the entire realm of macroscopic phenomena. No mathematical bridge led from quantum theory to the theory of relativity. From 1924 onward Eddington worked relentlessly to produce "a harmonization rather than a unification," of these two. The result is a theory which relates all the fundamental physical constants both atomic and cosmic. In 1936 he wrote, "Unless the structure of the nucleus has a surprise in store for us, the conclusion seems plain—there is nothing in the whole system of laws of physics that cannot be deduced unambiguously from epistemological considerations." The link is made by identifying a function of the number of independent wave-systems existing in the universe with the ratio of electrical to gravitational force between a proton and an electron. This work stands as a monument to a very great thinker. He has written (1932): "A slight reddening of the light of distant galaxies, an adventure of the mathematical imagination in spherical space, reflections on the underlying principles implied in all measurements, nature's curious choice of certain numbers such as 137 in her scheme—these and many other scraps have come together and formed a vision." And with a humorous touch he adds—"a most rare vision . . . Bottom's dream."

This work has drawn fire from Dingle, Born and others because they regard with distrust such pure Aristotelianism. Born has recently written "If they (Eddington's results) should turn out to be right I shall rejoice. But I shall not attribute this (possible) success to Eddington's philosophy, as a doctrine which could be followed by others, but to his personal genius and intuition." This, to my ears, has the sound of evasion. The Astronomer Royal has ventured the opinion that "it may well be that generations yet to come will regard Eddington's recent work as one of the most important and significant advances in science." Unfortunately few scientists and fewer philosophers have the mathematical competence to understand it fully.

Other avenues of attack have been explored in 1943-44 by Saxby, by Einstein and Bargmann, and by Schroedinger, all realizing the

need of a unified theory embracing gravitation, electromagnetism and the meson field involving quantum laws. Their work develops directly from the earliest modifications of Einstein's original theory by Weyl and Eddington. It is not yet evident how successful these efforts may prove to be. Relatively few people have the training and urge to analyse such work critically. But there is good evidence that in this rarefied region the adventuring in ideas is by no means at an end.

I have dwelt at some length upon changing and developing cosmological ideas to drive home the truth of the assertion that man's interpretation of the drama of the universe has been and is a powerful influence upon philosophy in its widest sense. In the more personal and intimate philosophy which consciously or unconsciously guides the actions and attitudes of individuals in society, I believe there is need of a much greater influence from astronomy. Religion, or personal philosophy, has too often been a cause of dissention, hatred and war. Why? Is it because man is apt to be like Caliban imagining Setebos altogether such an one as himself? God, at worst a supermonster, at best a tribal deity! It is astronomy which provides the far vision in space and in time, giving us the cosmic setting so essential if we would see the world in true perspective and formulate an adequate philosophy. Like Kepler we should bow down before facts and let them speak to us. One of the facts of observation is that amid all the vastness of the stellar universe we know of one small planet upon which in the fullness of time there appears this being called man to whom truth, goodness and beauty are significant, sometimes so significant that he will count not his life dear unto himself that he may pursue these. A man's philosophy must face this fact squarely, as also the facts of the physical universe where natural law operates; a man's idea of a God must be so large that this God is Creator and Sustainer of the vast universe of stars and galaxies and also in some measure akin to the mind and spirit of man, striving, struggling, failing but striving again—both literally and metaphorically, towards the light.

Queen's University,
Kingston, Ontario.
January 19, 1945.

MINUTES OF THE ANNUAL MEETING OF THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

The Fifty-fifth Annual General Meeting was held in the McLennan Laboratory on Friday, January 12th, 1945, the President, Dr. A. Vibert Douglas, being in the chair.

Minutes. The minutes of the last Annual Meeting were read and adopted.

Business from Minutes. (1) Sale Price of Publications. The General Council recommends that no change be made. The recommendation was adopted. (2) Inventory and Insurance. Dr. Best, Acting Librarian, reported to the Council that the property of the Society at 198 College Street and at the Dunlap Observatory was considered to be worth in the neighbourhood of $4,000, and the Executive was asked to provide what they considered adequate insurance. This report was confirmed.

It was suggested that an enquiry be inserted in the JOURNAL regarding the whereabouts of some of the Society's telescopes which have been missing for some time; also a set of lantern slides.

Scrutineers. On motion, duly seconded and carried, Miss Budd, Mr. Duncan and Mr. Crook were named as scrutineers, and were allowed to retire from the room in order to count the ballots.

General Secretary's Report. Mr. Kennedy reported an increase in membership during 1944 from 1136 to 1221. He also announced the formation of a Centre of the Society in Windsor, Ont. (A more detailed report will be found elsewhere in the JOURNAL.)

Eclipse. Some discussion took place about the possibility of making up a party to go to Western Canada for the total eclipse of the sun on July 9th. Action was deferred.

Cable from Russia. The General Secretary read a long and interesting cablegram from Russia regarding the forthcoming eclipse and other matters. It was moved, seconded and carried that this cablegram be handed to the Editor of the JOURNAL.

General Treasurer's Report. Mr. Horning reported, showing General Fund receipts (including balance from the previous year) of $6,211.50, and disbursements $4,865.14, leaving a balance on hand of $1,346.36. There is a bank balance of $23.48 in the Life Membership account, $77.87 in the Building Fund and $137.99 in the Southam Press Fund. The Society's bond investments now total $9,450.00. The report was adopted.

Auditors. Mr. Barker reported for the Auditors, whose work was made easy not only by the care of the Treasurer but by the help Mr. Kennedy has given in the office by periodically summarizing the receipts. Mr. Barker and Mr. Andrew Thomson, the auditors, received the Society's thanks, and were reappointed for 1945.

Librarian. Dr. Best gave a report as Acting Librarian. This report was adopted, and appears elsewhere in this JOURNAL.

Honorary Members. The President suggested that a memorandum setting out the grounds of the awarding of Honorary Membership be inserted in the General Secretary's report. It was so ordered.

Thanks to Officers. A hearty vote of thanks was given to the officers for their services during the year.

Election. The scrutineers reported that 250 ballots had been received, seventeen of which were disqualified. The Officers and Members of the Council elected are listed elsewhere in this JOURNAL.

Headquarters. It was reported that the University is planning to erect new buildings on College Street, and that the property occupied by the Royal Canadian Institute, where the Astronomical Society's office is located, will be required. As the General Council has already appointed a committee on Headquarters Office, no further action was taken.

The meeting then adjourned. H. W. BARKER, *Recorder.*

REPORT OF THE GENERAL SECRETARY FOR 1944

The upward trend in our membership continues. While the increase is not so noteworthy as last year it is most gratifying under the present very difficult conditions. The total is 1221.

For some time a number of interested devotees of the science have been meeting in the city of Windsor under the leadership of Mr. Cyril Hallam, a science teacher in Patterson Collegiate, and Mr. Gregory Rawlings. This group met monthly, and was organized under the name of the Astronomy Club of Windsor. They made formal application to the General Council to become a Centre of the R.A.S.C. The application was granted, and they have already appointed their officers and complied with the provisions of the Constitution. They start with 28 members and expect more to join shortly. Fees have been sent to the General Treasurer. We are glad to welcome Windsor to our growing family of Centres.

The reports from the Centres show increasing activity; some Centres, however, have not yet sent in reports. It is helpful to the Society generally to have the Annual Meeting acquainted with the progress and activity of the Centres across the Dominion. Although the Montreal Centre has lost some members since it reached its record total of 257 last year, it can show an excellent report of work done. With the 6-inch refractor mounted in the Ville Marie Observatory, 631 observations of 87 variables were made and reported to the A.A.V.S.O.; and no less than 40 monthly reports by members, of observations on the Aurora were sent to Dr. Gartlein of Cornell University. They have also fostered the visitation to their observatory by such groups as the Air Cadets, science classes from High Schools and other groups with good results. Quebec also sent in a splendid report, and has a group observing the Aurorae under the direction of Dr. Gartlein. For three years Quebec Centre has been constructing a dome and housing for its telescopes; it is now completed; most of the work was done by members. Quebec province has two very live Centres.

The popularity of the Observer's Handbook continues; although the number printed has been increased each year we have been short of the demand. The editors added 500 this year, printing 3600. Orders are now coming in so fast the indications are that even this large number will not see us through. The office is a busy place these days mailing out hundreds of individual orders to all parts of the globe. The Handbook is unique and the most useful book of its kind published. The editors and their staff are to be congratulated on their production and the thanks of the Society is due to those who give their time so willingly gratis.

Under the revised constitution a standing Committee consisting of the President and the two Past Presidents was appointed to nominate Honorary Members, not more than two each year. This committee reported to the General Council nominating Sir Arthur Eddington, University of Cambridge, and Walter Sydney Adams, Mount Wilson Observatory. These nominations were approved, but the ink on our records was scarcely dry when the sad news of the sudden death of Sir Arthur on November 21st was received. His loss will not only be keenly felt by astronomical circles but also by kindred societies all over the world.

REPORT TO GENERAL COUNCIL, R.A.S.C. FROM STANDING COMMITTEE ON HONORARY MEMBERS

We have noted that Honorary Members are to be selected "in recognition of scientific attainments of the highest order"; that ordinarily there shall not be more than two names submitted to the General Council in any one year; that these shall be submitted with a written statement of the reasons for bestowing the honour.

We are informed by the General Secretary that no one of the Honorary Members elected in years past is now living. The two names now submitted will therefore, if they accept nomination, and when elected by the General Council, form the first of an entirely new list of Honorary Members. Every name that is added as the years pass should be of such outstanding merit that the Royal Astronomical Society of Canada will feel itself honoured to have them enrolled on this list. The method of selection is one suggested by J. A. Pearce.

The result of the voting is that we nominate for Honorary Membership:—

SIR ARTHUR STANLEY EDDINGTON, O.M., M.A., D.Sc., LL.D., F.R.S.
Plumian Professor of Astronomy in the University of Cambridge, England.

WALTER SYDNEY ADAMS, A.M., Sc.D., LL.D.
Director, Mount Wilson Observatory, California, U.S.A.

Sir Arthur Eddington has been contributing to the progress of astronomy and cosmology for about forty years in fields as diverse as stellar movements, internal constitution of the stars (radiation pressure, pulsating stars, stellar diameters and densities, white dwarfs, central temperatures), mathematical theory of relativity, cosmological and physical constants, combination of relativity and quantum theories. His papers before the Royal Society, The Royal Astronomical Society and other national and international scientific bodies have placed him in the very forefront of the world's scientists. His expositions in *The Nature of the Physical World*, *New Pathways of Science*, and *Philosophy and Physical Science*, have been stimulating to scientists, philosophers, metaphysicians and thinking laymen in many countries. His insight and powerful thinking have placed his work at the foundations and within the superstructures of many investigations still in progress. We are proposing an honour to our R.A.S.C. in suggesting that Sir Arthur Eddington be asked to accept honorary membership.

Dr. Walter S. Adams is one of the most outstanding of American Astronomers. He early gained a reputation in solar and stellar spectroscopy and particularly in radial velocity work, being awarded the Gold Medal of the Royal Astronomical Society in 1917 and the Draper Medal of the National Academy of Sciences in 1918. He has been Director of Mount Wilson Observatory since 1923. He was a pioneer in the determination of absolute magnitudes, and hence of stellar distances, by means of sensitive and characteristic features of the spectra. Under his direction many remarkable pieces of research have been undertaken and carried through at Mount Wilson. If he will accept Honorary Membership the R.A.S.C. will be honoured.

A. VIBERT DOUGLAS, *Chairman*
J. A. PEARCE
F. S. HOGG.

November 6, 1944.

It will be a matter of interest and regret to the members of the Society to learn that our tenancy with the Royal Canadian Institute will expire shortly. No definite date is set, but the University of Toronto plans to tear down the building at 198 College Street and to construct a large modern building on the site. A committee has been appointed to canvass all the possibilities to obtain a future location suitable for the headquarters and library of the Society.

During the year the Academy of Scientists of the Soviet Republics sent their greetings by wire, to which we responded, reciprocating their good wishes. A few days ago we received another long cable setting out the Academy's programme for expeditions to observe the Solar Eclipse in July of this year. Twenty-two different expeditions including 100 specialists will be sent to different stations. (This report appeared in the February JOURNAL.)

We salute our retiring president, Miss A. Vibert Douglas, who has the honour of being the only woman holding the office of President since the inception of our Society over 50 years ago.

E. J. A. KENNEDY, *General Secretary*.

REPORT OF THE LIBRARIAN

During the year 1944 periodicals were received

From Canada and the Empire	36
" the United States of America	99
" other countries	14
	149

The number of books loaned from the shelves during the year—210. Expenditure during the year was:

For new books	$ 2.05
For binding	30.78
Total	$32.83

New books added to the library in 1944 are:

"Physics and Philosophy," Sir James Jeans.

"The Clock Book," by Wallace Nutting.

The last named book was presented to the Society by Mr. H. W. Barker, of Toronto, Recorder of the R.A.S.C. and is here acknowledged with cordial appreciation.

It may be mentioned here that we are now receiving the Monthly Weather Map from the Dominion Meteorological Service. We have also on file a complete series of the Journal of Calendar Reform.

P. M. MILLMAN, *Librarian*. per D. W. BEST, *Acting Librarian*.

REPORTS OF SECRETARIES OF THE CENTRES

Toronto Centre

Meetings. During the year there were held 3 Council meetings, 11 regular meetings. Five Summer outdoor meetings were arranged for, one of which had to be adjourned on account of unfavourable weather conditions. The indoor regular meetings were held in the McLennan Laboratory of the University of Toronto, the outdoor meetings on the University Campus.

The subject and speakers for the meetings were as follows:

February 1,—Squadron Leader J. F. Heard: "History of Navigation."
February 15,—D. W. Best, D.D.: "Our Nearest Star—the Sun."
February 29,—C. A. Crook: "Our Planetary Neighbours."
March 14,—F. L. Troyer and H. Duncalfe: "Wonders of the Moon."
March 28,—H. W. Barker: "Visitors from Space—Comets and Meteors."
April 11,—Edna M. Fuller, B.L.S.: "Telescopes the World Over."
October 10,—Dr. Helen Sawyer Hogg: "Recent Astronomical Progress as Reported to the American Astronomical Society."
October 24,—Frederic L. Troyer and J. R. Gilley: "Our Calendar—Past, Present and Future."
November 7,—Professor A. MacLean: "Earthquakes and Volcanoes."
November 21,—R. T. Jacobsen: "Radiosondes."
December 5,—H. S. Barker: "Some Ancient Astronomers."

The Annual Business Meeting and Election of Officers of Toronto Centre followed this meeting.

The outdoor meetings were held on May 26, June 30, July 28, August 25 and September 29.

At each of the Spring meetings current astronomical happenings were briefly reviewed by Miss Northcott, and at the Autumn meetings, Mr. C. A. Crook presented "Explanations of Astronomical Terms," when time was available.

A new procedure, which proved popular as regards the Library, was the opening of the Library for a short period of time, under the supervision of Miss E. M. Budd, *after* each lecture meeting, for the inspection, borrowing and returning of books.

Membership. As of December 31, 1944, there are 239 members on the roll, of whom 10 are life members. There were 37 new members elected during the year and 6 removed for various reasons, leaving a net gain of 31.

Tracy D. Waring, *Secretary.*

Ottawa Centre

The Annual Meeting of the Ottawa Centre was held in the Museum Lecture Hall on Dec. 13th at 5.15 p.m., the President, Dr. T. L. Tanton, in the chair. The minutes of the last annual meeting and of the last council meeting were read and approved.

Dr. Tanton gave a short but very interesting Presidential Address, of which the following is a résumé:—

Conchilites: In Relation to a Theory of the Origin of Life on Planets.

A collection of shell-shaped objects, new to science, discovered by the speaker in 1943, at a depth of 30 feet below normal level on the bed-rock floor of Finlayson Lake, Rainy River District, was on exhibit. These objects, which he called Conchilites, are composed of hydrous iron oxides, magnetite, and minor amounts of manganese, silica and other materials. His interpretation of their origin is that they were deposited from iron-bearing colloidal solutions that formed a semi-permeable membrane between mineralized solutions in the porous rock below and the lake water above, thereby inducing osmosis; the deposits grew, as parts of single cell structures, by rhythmic internal and marginal accretions. The gross structures of Conchilites, though exhibiting the phenomenon of growth in a manner common to living organisms, are apparently lacking in power of reproduction, and on this account are at present classified as non-living (or possibly semi-living) material.

Within some of the Conchilites there are minute structures that have been tentatively identified as deposits formed by bacteria or other low forms of life.

Dr. Tanton advanced the theory that primitive organisms, of the general nature of the bacterium Leptothrix, may have been evolved from non-living matter. This may have occurred as a result of complex chemical reactions, between the ferrous and ferric hydroxides (known to have been present) and other vital constituents whose presence may reasonably be assumed, rhythmically recurring in the favourable environment naturally provided by the growing Conchilite cell.

This theory is based on that presented by W. D. Francis of Brisbane, who, building on the work of A. B. Macallum and others, has demonstrated in the laboratory the synthesis of protein from its inorganic constituents by ferrous hydroxide, and has given reasons for regarding iron as the original basis of protoplasm. Francis regards Leptothrix as a primeval form of life. He says, "The repetition of the form of Leptothrix in chromosomes indicates that it is a fundamental form."

Dr. Tanton infers that the conditions favourable for the development of Conchilites, though now known at but one locality, may have existed at various times elsewhere, and particularly on Mars. Astronomers, aware of the evidence that there must have been a beginning of life, independently, on both Mars and the Earth, now regard Conchilites as a semi-living, evolutionary medium for

providing suitable nourishment, physical conditions and environment for inducing the emergence of a primeval form of life.

The treasurer's report showed that receipts for the year (including balance from 1943) were $426.96; expenditures, $169.76; leaving a balance on hand of $257.20.

Reports on activities showed that two well-attended public lectures had been held (both reported in the JOURNAL).

The weekly "Sky Facts" column, a feature arranged through co-operation with the Ottawa *Citizen*, had continued successfully through the year, and attracted many queries and much favourable comment.

The Junior Club had passed a successful season under the leadership of Miss M. S. Burland and Mr. B. L. Bradley, and was looking forward enthusiastically to the coming one. The meeting highly commended the club and its leaders.

Handbook sales had continued their upward trend, 140 having been sold in the past year as against 105 the year before (both figures exclusive of those distributed to members in the ordinary manner).

There were high hopes for some good lectures in the new year, as well as hopes that some discontinued activities might be resumed if "the boys come home."

F. W. MATLEY, *Secretary*.

HAMILTON CENTRE

During the year the Hamilton Centre held eight regular meetings and one Field Night, also three Council meetings to discuss the business of the Centre.

January 6,—Prof. R. M. Wiles, Ph.D.: "Thomas Hardy and the Stars."
February 3,—William McCallion, B.A.: "Newton's Three Laws of Motion."
March 2,—Dr. W. H. McNairn: "The First Great School of Astronomy."
April 6,—Dr. A. N. Crooker: "Military Telescope Making."
May 4,—Flt. Lieut. J. Dooley: "Astral Navigation."

May 29,—Field Night: Held in the grounds of Mr. W. T. Goddard. A large number of portable telescopes were erected, including a new 8-inch reflector built by one of our members, who ground and polished the mirror himself; this was his first mirror and is an excellent job, with good definition. Luncheon was provided by Mr. Goddard and about two hundred members and friends enjoyed his hospitality.

October 5,—Ladies' Night: featuring Mr. G. E. Campbell, M.A., reminiscing on the 1932 Solar Eclipse expedition, with lantern slides.

November 2,—Mr. W. S. Mallory, M.A.: "The Science of Meteorology."

December 7,—Mr. T. M. Norton: "Varying effects of Sun-spots."
This was the annual meeting for the election of officers.

The meetings throughout the year were of an educative nature as well as entertaining, and our chairman, Mr. W. D. Stewart, did a good job in securing speakers both for the main lectures and curtain raisers.

Paid-up membership to date is 42.

We regret the death of two of our members, Mr. F. A. Magee, June 9, and Mr. T. H. Wingham, July 26. Four of our members have joined the Air Force.

JAMES R. GRAHAM, *Secretary-Treasurer.*

WINNIPEG CENTRE

During the year 1944 the following meetings were held in the University Buildings:

January 13,—Mr. L. W. Koser: "Outline of the History of Astronomy."

February 10,—Ft. Lieut. Fowler: "Some Developments in Aerial and Other Forms of Photography."

March 9,—Prof. J. W. Lawson: "Freedom and Astronomy."

April 13,—Mr. H. E. Riter: "The Nebulae."

May 26,—Dr. C. S. Beals: "Interstellar Matter."

November 9,—Mr. R. A. Storch: "Problems Involved in Travelling Through Outer Space."

December 14,—Mr. L. T. S. Norris-Elye: "The Moon."

One Executive meeting was held, when the programme for the year was outlined. An observation meeting was called for October 28, but had to be cancelled because of weather conditions.

There are at present 28 paid-up members, two new members having been elected since January last.

MARGARET E. WATTERSON, *Secretary.*

Montreal Centre

During the past year, in spite of many difficulties and handicaps caused by the war, the Centre has continued to carry on an active programme. The Montreal Centre has a paid-up membership of 212 persons.

Seven general meetings were held during the season at which the following speakers were kind enough to address us: Mrs. E. R. Adair, Miss E. Achelis of New York, Dr. W. Rowles, Dr. J. W. Bridges, Mr. F. P. Morgan, Dr. A. V. Douglas of Queen's University, and Dr. D. A. Keys.

Among the most important of our activities have been the Saturday Evening Observation Meetings held under the direction of the Telescope Committee, under the chairmanship of Mr. DeLisle Garneau, at the Ville Marie Observatory. These meetings and other activities will be reported by Mr. Garneau. I would like, however, to express the thanks of the Centre to him for his able and untiring efforts.

I feel also that the sincere thanks of all of us should be expressed to Miss Isabel Williamson for her splendid and continuous work, not only as Recording Secretary, but also in connection with newspaper reports and in observations and other activities. Mr. John W. Duffie has also been a tireless worker as Librarian and in many duties of a secretarial nature. Mr. F. J. DeKinder has also continued to do excellent work as an efficient Treasurer—a sometimes thankless but most important work in a Centre as large as ours has come to be. These members and others deserve our thanks for carrying on many detailed activities under conditions which are often very difficult and for which there is no reward except the satisfaction of good work well done.

The enthusiasm of our President, Mr. D. P. Gillmor, has been an inspiration to us all and he has promised to give a brief report at the next meeting in which he will, no doubt, report more fully on the activities of the Centre.

In conclusion I should like to have the privilege of thanking a good friend and fellow-member, Dr. A. Norman Shaw, Chairman of the Department of Physics, McGill University, and, through him, the University itself, for continued generosity in providing this

splendid building for the use of the Centre. May I also offer the thanks of the Centre to the Press for their continued support in reporting astronomical events as well as our meetings. In this connection I should like to thank especially the *Monitor* and its editor, Mr. Edgar, for their obvious interest in the work and activities of the Society.

HENRY F. HALL, *Secretary.*

Report of Telescope Committee. In presenting the third annual report of Ville Marie Observatory, I wish to mention first of all the wonderful work accomplished by Messrs. D. E. Douglas, C. M. Good, F. W. Henshaw and F. T. Matthews in the construction of an equatorial mounting for the Society's 6-inch refractor. They deserve high praise and the Society owes them a debt of gratitude.

The total attendance at the Observatory during the past year was 980. This is more than double last year's figure of 415 and is very gratifying. Fifty regular observation meetings were held at the Observatory with members of the Telescope Committee in charge. Besides these, two constellation meetings, under the direction of Mr. F. J. DeKinder, were held on the grounds of Lower Canada College.

The following groups also visited the Observatory: the Natural Science Class of Sir George Williams College, under the guidance of Dean Henry F. Hall; the Quid Novi Society; the Daniel O'Connell Squadron of Air Cadets, under the direction of F/O. G. B. Moxon; Les Jeunes Laurentians; the Know Canada Assn., under the direction of Miss I. K. Williamson; the science class of Grade IX of West Hill High School, under the direction of Mr. C. M. Good; the Institut de la Nouvelle France; and eleventh grade students of Town of Mount Royal High School.

A word may be said of activities of members outside the Observatory. Miss Williamson conducted a constellation meeting at the Y.W.C.A. Mr. Russell Paterson, outside of his regular courses at Sir George Williams College, delivered a series of lectures on Astronomy at the Jewish Library, and other lectures on the same subject before the Geographical Society and at the Town of Mount Royal High School, besides giving instruction to Boy Scouts. In fact, during the past 18 years Mr. Paterson has taught Astronomy to over 1800 scouts. At his home in Sault-au-Recollet, Mr. DeKinder has built an observatory with a revolving dome and an equatorial mounting driven by clockwork for his 4-inch refractor. Mr. Henshaw has completed and put to considerable use a 5-inch reflector. Several other members have reflector telescopes in the course of construction.

In the field of observation I have the following to report:

Six lunar occultations were observed, including that of Jupiter on January 13.

Members of the Aurora group, under the direction of Miss Williamson, sent 40 monthly summary reports and 35 descriptive reports of aurorae to Cornell University.

Six hundred and thirty-one observations on 87 variables were made by Mr. John Duffie and myself and monthly reports forwarded to the Recorder of the A.A.V.S.O.

Regular observations of the sun were carried out with the Society's 6-inch refractor.

The annual Perseid meteor shower was also observed and recorded by many members of our local Centre. We have received substantial reports from Mr. I. Ginsberg, who with a group of friends plotted these meteors at Liberty, N.Y., from Mr. J. E. Guimont and from Mr. A. V. Madge. At Ville-Marie Observatory 134 meteors were recorded on the night of August 11-12 and 68 more on August 12-13.

DeLisle Garneau, *Chairman Telescope Committee.*

Report of the Librarian. During the year a slight increase was noted in the circulation of books from the Library, 126 volumes being borrowed by members.

A number of valuable books were presented to the Library through the generosity of some of our members, as follows:

Les Temps Mythologiques,		
Les Mondes Imaginaires,		
Propos Scolaires		
T.S.F. Avec les Etoiles	presented by	Mr. J. E. Guimont
L'Astronomie	"	" Mlle. Lavigne
Secrets of the Stars	"	" Miss Smardon
Nature of the Physical World	"	" Miss Williamson

In addition, we purchased "Galaxies," by Harlow Shapley, and Volume 3 of the Leaflets of the Astronomical Society of the Pacific, bringing to 100 the number of books in the Library. Our subscription to "Sky and Telescope" magazine is being continued.

Copies of the "Journal of the Royal Astronomical Society of Canada" for the years 1936 to 1943 were bound in permanent form, thus completing our files of this publication for the years 1925 to 1943 inclusive.

J. W. Duffie, *Librarian.*

Victoria Centre

Membership. During the year 1944, our membership has dropped by ten members. While we have enrolled 12 new members, 22 members have been lost to the Centre for the following reasons: 2 deceased, 5 resigned or transferred to other Centres, and 15 dropped for non-payment of dues, leaving the present total at 95, made up as follows: life members 3, junior members 3, regular members 89; total 95.

Meetings. Sixteen meetings were held during the year, including 7 general meetings, 4 Council meetings and 5 Summer Course meetings. General meetings consisted of the Annual Dinner, December 17, 1943, a visit to the Planetarium, R.C.N. College, Royal Roads, and 5 lectures.

Summer Course. Twenty-three members enrolled for the Summer Course, which consisted of 3 lectures and 2 outdoor observational meetings. An average attendance of 50 to 60 was maintained throughout the course.

Observing Section. This fall an Observing Section was formed, as a new activity of the Society. A separate report of this group will be given.

Conclusion. While there has been a decrease in our total membership this year, the interest of the members has been keen. With the newly acquired facilities for observing, the Centre should have a very successful year in 1945.

MIRA V. YARWOOD, *Secretary.*

LONDON CENTRE

During the year 1944 the London Centre held seven regular meetings. The programme of each meeting included a discussion of the Observer's Handbook and other items of astronomical interest. The details of the separate meetings follow:

February 4,—Public meeting at the London Public Library. Dr. C. Sivertz: "Science and Society."
March 3,—Dr. Watt and Dr. Spratt: "Homemade Telescopes."
April 14,—Mr. Omar Kilburn: "Astronomical Photography."
May 5,—Dr. H. R. Kingston: "Variable Stars."
October 6,—Mr. A. Emsley: "Biography of Sir Isaac Newton." Sound Films: The Earth in Motion, The Solar Family.
November 3,—Professor G. H. Reavely: "The First Thousand Million Years." Rev. W. G. Colgrove: "The Next Thousand Million Years."
December 8,—Annual Meeting. Reports and election of officers.
Sound Film: Nautical Astronomy.
Refreshments.

Members of the society assisted at several public meetings held during the year. The total attendance, excluding the annual meeting, was 197. The paid-up membership on this date is 39.

R. H. COLE, *Secretary.*

Vancouver Centre

During 1944 seven regular meetings of the Centre were held in Room 200 of the Science Building of the University of British Columbia.

An excellent programme of addresses on interesting topics was enjoyed by members and their friends during the year.

The following is a list of speakers and their subjects:

January 11,—J. G. Hooley, Ph.D.: "Modern Telescopic Optical Glass."
February 8,—J. H. L. Watson, Ph.D.: "Applied Electron Microscopy."
March 14,—K. O. Wright, Ph.D.: "Methods in Stellar Spectroscopy."
April 11,—Wm. F. Seyer, Ph.D.: "The Age of the Earth."
October 10,—H. D. Smith, Ph.D.: "The Time Scale of the Universe."
November 14,—Mr. Walter J. Lind: "The Magic of the Spectrum."
December 12,—R. E. G. Langton: "Cosmic Rays."

The meetings were well attended, and spirited discussions arose at the close of the lectures. Approximately 60 persons received the monthly notices of the regular meetings.

Norman Barton, *Secretary.*

Edmonton Centre

Two council meetings were held during the year to arrange the programmes, the speakers, and to transact other business.

The meetings have been held in the Arts Building through the courtesy of the university authorities. The annual meeting, as usual, took the form of a dinner in the Corona Hotel. The attendance varied from 27 to 55 people, the average being 35.

The Handbook talks were given by Mr. Wates and Dr. Campbell. There were not very many short talks on constellations, etc. There should be more suggestions and contributions from members for this preliminary part of the programme.

The main parts of the programme were as follows:

December 1943,—Dr. J. R. Tuck: "Star Mythology."
January 1944,—Flt.-Lt. Crossley: "Astro-Navigation."
February,—Miss Malanchuk: "Mars."
March,—Dr. D. B. Scott: "Telescopes and their History."

April,—Showing the slides of Mars.
May,—Mr. H. R. Milley: "The Milky Way."
May (Special),—Dr. C. S. Beals: "Inter-stellar Matter."
October,—Mr. C. G. Wates: "Changes in the Universe."
November,—Dr. E. H. Gowan: "Telescope Faults."

Observation nights for members, and for the general public have been arranged, and the response has been good.

The roll of the Centre now consists of 57 regular members, and 6 associates.

E. H. GOWAN, *Hon. Secretary.*

QUEBEC CENTRE

During the year 1944 the Quebec Centre had its membership increased from 70 to 81, despite 10 withdrawals registered in the course of the year and the members maintained their high grade activity of the past. Particularly worthy of mention is the work of two young members, Messrs. Charles-Aimé Giroux and Raymond Fortin. The former spent his holidays working at the Observatory of the Centre, where he was acting as assistant to the director, and was also a regular speaker at our monthly meeting with his description of the sky. The latter, a draughtsman by profession, made two splendid star maps *Voûte étoilée pour les quatre saisons* and a *Grand planisphère céleste*. Not less than 9700 objects are represented on the planisphere, which required over five hundred hours of work.

At the end of September our Centre asked the Maryland Academy of Sciences for permission to prepare a translation of its Graphic Time Table, with minor corrections for the latitude of Quebec city. Dr. Paul S. Watson answered that our request was approved, and furthermore that the Academy would be glad to undertake the entire work of preparing a French edition for latitude 47°, that is approximately that of our city. Dr. Watson sent us eight hundred copies for free distribution.

Recently, after the suggestion of Dr. C. W. Gartlein, our Centre organized a group of aurora borealis observers, disseminated throughout the province. The group now has twenty members and many of them are sending in regular reports.

The telescope makers showed an increased activity during the year as a result of more facilities in obtaining materials, while the writers of weekly newspaper articles on popular astronomy maintained their series. Twenty-seven out of the fifty-one articles were extracts from the French translation of Dr. Chant's *Our Wonderful Universe.*

The monthly meetings were ordinarily held in the amphitheater Lavoisier of Laval University. The titles of the main addresses follow:

January 26,—Prof. Henri Paul Koenig: "Les Rayons Cosmiques."

February 23,—Mr. Lucien Pouliot: "Météorites et Cratêres Météoriques."

March 29,—Reading with explanations of an article published in the review La Nature, "L'Enigme des Etoiles Naines," by M. Pierre Rousseau.

April 26,—Mr. Geo-Etienne Gagné: "La Nature du Sol Lunaire."

November 29,—Two addresses on the subject, "La Pluralité des Mondes habités," M. l'abbé Emilien Gauthier defending the affirmative M. Paul-H. Nadeau the negative.

December 19,—M. Charles-Aimé Giroux: "L'Etoile de Bethléem."

Besides these meetings the Centre organized a popular star party in the city of Montmagny, near Quebec, on May 27, and the success was complete, due to the valuable collaboration of a member of this place, M. Robert Proulx. On October 5, was held at the Observatory the first meeting specially organized for the benefit of the members and the programme consisted in describing some aspects of practical astronomy. Finally, on Decémber 13, the members were the guests of the Institut de Chimie du Canada, Section de Québec, to hear Prof. F. Paneth speaking on "Meteorites and the Age of the Solar System."

The construction of the Observatory of the Centre was completed during the summer of this year after three years of work. The blessing was held on October 22, with Mgr. Cyrille Gagnon, Chancellor of Laval University, as officiating minister. The mechanical resistance of the dome, constructed by the members themselves, was put to a serious test during the storm of November 30, but suffered no damage, whilst in less exposed parts of the city numerous roofs were pulled up.

The library of the Observatory has been enriched by many gifts

during the year. A collection of the *Bulletin* of the Société Astronomique de France from 1924 to 1938 was graciously contributed by the Victoria Centre of the R.A.S.C.; M. Arthur Amos sent a collection of ten years of the JOURNAL of the R.A.S.C.; Dr. Frank S. Hogg, of the David Dunlap Observatory, two French books, and M. Jos.-Edgar Guimont, of Montreal, six books by Flammarion and others.

Practical observing was maintained at a high level at the Observatory, but with only one member engaged. The work consisted of variable stars, northern lights and sun-spots. From December 1943 to December 1944, 1186 estimates have been made, that is 231 less than the previous year, a diminution partly due to bad weather.

Visiting hour was more popular than ever and we welcomed about 1700 persons, more than the two previous years together. The staff in charge of the visitors had to be enlarged, specially in the summer months.

But we have not only happy events to report here: 1944 was a year of mourning for our Centre. First, we lost our great protector and honorary president, Monsieur Germain Beaulieu, who died at Rigaud on June 18, and recently a friend of our society, Mgr. Aimé Labrie, Vice-Chancellor of Laval University.

PAUL-H. NADEAU, *Secretary*.

FINANCIAL STATEMENTS, 1944

I. GENERAL TREASURER

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Revenue

Grants Received	$2,120.00	
Fees and Subscriptions	2,166.82	
Life Membership Fees	75.00	
Sale of Publications	1,016.47	
Interest on Bonds	310.31	
U.S.A. Exchange	67.00	
		$5,755.60

Expenses

Cost of Publications	$3,257.68	
Grant to Centres	864.00	
Salaries	780.00	
Stamps, Stationery	100.96	
Rent	125.00	
General Expense	78.29	
Janitor	21.00	
Bank Interest and Exchange	3.57	
Chant Medal	6.75	
		5,237.25
Excess Revenue over Expenditures		$ 518.35

Toronto, January 9, 1945

Audited and certified correct:

Andrew Thomson, *Auditor*

H. W. Barker, *Auditor*

J. H. Horning,

General Treasurer.

II. REPORTS OF TREASURERS OF CENTRES

TORONTO CENTRE

Receipts		Disbursements	
Balance from previous year	$209.73	Rentals	$ 52.00
Grant from General Council	195.00	Printing	30.12
Members' Fees	407.25	Postage per General Secretary	10.55
		Balance carried forward	312.06
		Fees to General Treasurer	407.25
	$811.98		$811.98

December 5, 1944.

T. H. Mason, *Treasurer.*

OTTAWA CENTRE

Receipts		Expenditures	
Balance from previous year	$204.70	Fees to General Treasurer	$ 84.00
Members' Fees	92.00	Purchase of handbooks	28.36
The Ottawa *Citizen*	50.00	Expenses in connection with meetings	47.85
Grant from General Council	46.00	Postage	9.55
Bank interest	1.36	On hand	257.20
Sale of Handbooks	32.90		
	$426.96		$426.96

December 3, 1944.

A. C. Steedman, *Treasurer.*

HAMILTON CENTRE

Receipts		Disbursements	
Balance from previous year	$ 40.40	Rent	$ 27.50
36 Members' Fees	72.00	Fee to Treasury	84.00
Grant from Treasury	43.00	Postage and Stationery	12.53
Donation	1.00	Printing	13.96
Bank interest	.52	Balance forward	18.93
	$156.92		$156.92

December 12, 1944.

James R. Graham, *Sec.-Treasurer.*

WINNIPEG CENTRE

Receipts		Disbursements	
Balance from previous year	$ 59.29	Rentals	$ 6.00
31 Members' Fees	62.00	Fees to General Treasurer	62.00
Grant from General Council	27.00	Postage and Stationery	2.80
Bank interest	.52	Expenses re meeting	2.00
		Slides	6.53
		Bank operating cost	.20
			$ 79.53
		Balance carried forward	69.28
	$148.81		$148.81

MISS SHIRLEY COLQUETTE, *Treasurer*.

MONTREAL CENTRE

Receipts

Cash on hand October 16, 1943	$166.65
Membership Fees Received	448.00
Interest from Provincial Bank	4.25
Grant from General Treasurer	256.50
	$875.40

Disbursements

Notices of Meetings	$ 25.26	
Stamps, Postcards, Exchange on Cheques	42.60	
Stationery, Rubber Stamps	8.91	
Expenses re Meetings, Telegrams	48.54	
Advertising	17.20	
Insurance	25.00	
Library	33.33	
	200.84	
Fees to General Treasurer	448.00	
		$648.84
Balance in Provincial Bank on October 15, 1944		$226.56

F. DE KINDER, *Treasurer*.

VICTORIA CENTRE

Receipts		Disbursements		
Balance from previous year	$ 24.79	Rentals		$ 17.50
Members' Fees	168.00	Fees to General Treasurer		138.75
Grant from General Council	85.00	Postage and Stationery		22.93
Bank interest	2.75	Expenses re meeting		17.40
Net proceeds Summer Course	3.85	Sundry:		
		Annual Dinner, 1943	$9.00	
		Library	7.87	
		Insurance	4.30	
				21.17
		Balance carried forward		66.64
	$284.39			$284.39

LONDON CENTRE

Receipts		Disbursements	
Balance from previous year	$ 34.03	Rentals	$ 2.00
39 Members' Fees	78.00	Fees to General Treasurer	
Grant from General Council	41.00	Postage and Stationery	11.88
Bank interest	.40	Expenses re Meeting	12.05
		Books	2.88
		Miscellaneous	5.15
		Balance carried forward	119.47
	$153.43		$153.43

December 8, 1944.

RANDAL H. COLE, *Treasurer.*

VANCOUVER CENTRE

Receipts		Disbursements	
Balance from previous year	nil	Rentals	nil
41 Members' Fees	$ 82.00	Fees to General Treasurer	$107.00
Life Membership	25.00	Postage and Stationery	11.63
Grant from General Council	52.00	Expenses re Meetings	25.10
Bank interest	1.23	Deficit from 1943	14.39
		Bank balance	2.11
	$160.23		$160.23

F. G. BERTON, *Treasurer.*

EDMONTON CENTRE

Receipts		Disbursements	
Balance from previous year	$114.03	Rentals, Janitor service	$ 10.56
Members' Fees	93.00	Fees to General Treasurer	12.00
Grant from General Council	48.80	Parent Society	98.03
Bank interest	1.61	Refreshments	1.50
Students' Handbooks	3.00	Memorial Flowers	6.06
		Dr. Beales' hotel fare	2.71
		University Book Store	23.00
		Balance carried forward	106.58
	$260.44		$260.44

A. M. P. Smith, *Treasurer.*

CENTRE DE QUÉBEC

Recettes		Déboursés	
Solde, 15 décembre 1943	$205.73	Emprunt 1943	$142.20
Octroi du bureau chef	69.50	Papeterie	15.32
Cotisations 1943	18.00	Electricité	10.88
" 1944	98.75	Timbres-poste	25.48
" 1945	13.25	Divers	12.65
Dons	39.49	Propagande	19.37
Intérêt de banque	.86	Réparations	58.38
		Outils	5.02
		Solde 15 décembre 1944	156.28
	$445.58		$445.58

J. L. Pouliot, *Le Trésorier.*

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President—HOYES LLOYD, M.A.
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Chairman of the Telescope Committee—DE LISLE GARNEAU
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Recorder—MRS. W. H. STILWELL, B.A. *Librarian*—MISS Y. LANGWORTHY
Council—LT. CMDR. C. A. MCDONALD; MRS. J. R. NOBLE; LT. COMDR. A. SCAIFE; W. H. STILWELL; C. H. SUMMERS; DR. W. P. WALKER.

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President—N. D. B. Phillips
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Secretary—E. H. Gowan, University of Alberta
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Social Hostess—Miss A. Malanchuk
Council—F. C. Blower; S. G. Deans; G. W. Robertson; D. B. Scott; C. G. Wates.

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Président—Jean-Chs Magnan, B.S.A.
Vice-Président—Lucien Pouliot, C.G.A.
Secretaire—Paul-H. Nadeau, M.Sc., 275 rue St-Cyrille
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Membres du Conseil—l'abbé Emilien Gauthier; l'abbé Rosario Benoit; Lionel Lemieux, B.A., LL.L.; Henri-Paul Koenig, M.Sc.; Marie-Louis Carrier, L.C.; Alberic Boivin, e.e.phy.; Geo-Etienne Gagné.

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Past-President—Lorne R. Rogers
Vice-President—Gregory Rawlings
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Treasurer—Cyril B. Hallam
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MEMBERS UNATTACHED TO CENTRES, ELECTED FEBRUARY 16, 1945

ADDA, LIONEL P., 393rd Infantry, U.S.A. Army.
ARROWSMITH, H. E., 119 179th St., St. Albans 12, L.I., N.Y.
BENNETT, E. A., 104 Lowell St., Galt, Ont.
BLAKELY, ALEXANDER M., 70 Water St , West Haven, Conn.
BRAUER, HOWARD H., 76 East Blvd., Rochester, 10, New York, N.Y.
BROOKS, ROBERT F., N.Y. Agric. Exper. Station, Geneva, N.Y.
BUCHWALD, JAS. P., 4407 Spokane Ave., Cleveland 9, Ohio.
BURKE, DAVID E., 29 Fairmount Blvd., Garden City, N.Y.
CAMERON, ALWYN J., University of New Brunswick, Fredericton, N.B.
CHOUINARD, WM. R., Lt., 353 Harbor Craft Co., New York.
EGGEN, OLIN J., Lt., Research and Development Dept., A.A.F., U.S.A.
FLAGG, HORATIO C., P.O. Box 236, Olympia, Washington.
FLUTOT, EDWARD, 1818 Monte Vista Drive, Whittier, Calif.
GLASS, GERALD T., 2207 Market St., Oakland 7, Calif.
GAGE, RICHARD, 1414 Clement St., Joliet, Ill.
GRANT, PERCIVAL L., Hamilton Rd., Dundah, Brisbane, Queensland, Australia.
HARE, EDWIN E., 1621 Payne Ave., Owensboro', Ky.
HARRIS, D. L., 1st Lt., III Ellington Field, Texas.
HECKENKAMP, E. B., Attorney, 2351 N. 83rd St., Wauwatosa, Wisc.
JOHNSON, E. H., Rock Rapids, Iowa.
KINDER, C. E., Cities Service Oil Co. Refinery Office, Titusville, Pa.
KINNEAR, WILLIS H., 12200 Blix St., North Hollywood, Calif.
MENZLER, G., 808 Myrtle St., Elizabeth, N.J.
NEWTON, GRADY, 1521 West 2nd St., Pine Bluff, Arkansas.
NOLAN, REV. FRANCIS, The Rectory, Robbinsdale, Minn.
OLSON, OTTO, 3102 95 St., Jackson Heights, N.Y.
PENTLAND, GEORGE E., Hanover, Ontario.
RIDDELL, A. H., 41 Linden Avenue, Haddonfield, N.J.
SAMPSON, L. H., 12850 Lauder St., Detroit 27, Mich.
SAXON, PAUL A., Med. Det. Sta. Hospital Camp, Blanding, Fla.
SCOTT, P. S., 4349 Draper Avenue, Montreal 28, P.Q.
SEIFERT, THERMAN L., R.D. 4, Bethlehem, Penna.
STEPHEN, F. A., 2200 Regent St., Montreal 28, P.Q.
SOUTHARD, MISS M., 1004 Massey Bldg., Birmingham 3, Ala.
SMITH, H. H., Jefferson St., Hazardville, Conn.
TAVES, E. D., 135 East 54 Street, New York 22, N.Y.
TIELMANN, OSCAR, 242 Fairview Ave., Paterson 2, N.J.
WATSON, J. C., 1204 South Birmingham Place, Tulsa 4, Okla.
WALTER, DAVID, Route 2, Wapato, Wash.
WALKER, E. R., Meteorological Office, Tofino, B.C.
WHITE, E. K., Chapman Creek, B.C.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Strange Phenomenon in the Sky

In the October 1944 JOURNAL (p. 351) and again in the December issue (p. 432) are some notes on a "Strange Phenomenon in the Sky."

It seems possible that the following phenomenon which the writer has seen very frequently may have some slight kinship with the "Strange Phenomenon in the Sky" discussed by Lieutenant Frank L. Tabruh, Major D. G. Revell and Mr. W. E. K. Middleton.

The Toronto, Hamilton and Buffalo Railroad line parallels the 110,000 volt, 25 cycle steel tower transmission lines running from Niagara Falls to Toronto, for many miles. Such "steam" from the locomotive as drifts through the transmission wires appears to be shaken violently up and down. Whether the "steam" and smoke particles actually vibrate up and down a couple of feet or whether, as appears more likely, the particles are intermittently lined up by the electrostatic stress in such a way as to make the "steam" near the wires seem alternately more and less dense, the writer has not been able to determine.

The writer presumes that the flickering effect produced occurs twice per cycle or fifty times a second. Not all eyes can detect it and the writer has sought for it in vain in New York State where the transmission lines carry sixty cycle current.

The phenomenon is not always visible, apparently depending somewhat on atmospheric conditions. It is the writer's recollection that it is most often seen on humid days, either summer or winter, when the steam is slow in evaporating into the atmosphere, but this may be because on damp days the steam persists in the atmosphere long enough to be blown in large quantities through the transmission wires.

D. W. ROSEBRUGH.

Dr. Shapley at the Royal Canadian Institute.

On Saturday evening, January 11, Dr. Harlow Shapley spoke in Convocation Hall, University of Toronto, at one of the series of weekly lectures sponsored by the Royal Canadian Institute. By special arrangement, the Royal Astronomical Society of Canada was invited to participate in this meeting, and many members of the Toronto and other Centres were present.

Dr. Shapley's subject was "Astronomy in Troubled Times," and dealt with recent advances and probable future trends in astronomical investigations. At this large meeting, and at several smaller, less formal gatherings which were crowded into a busy week-end, Dr. Shapley's usual enthusiasm and wide range of interests were a great inspiration to members of the Institute, the Astronomical Society, and the University staff and students.

F.S.H.

Snowbound

While our local record snows of December were followed by only normal snowfall in the following months, road conditions off the main highways of Ontario have been very difficult. It was not until March 6 that a bull-dozer cleared the snow from the Dunlap Observatory road, ending a period of twelve weeks during which the road was completely blocked. During this time the day and night work at the Observatory was each time prefaced and concluded by a cold, difficult walk and a cold, irregularly-timed tram journey.

F.S.H.

Staff Changes at American Planetaria

Mr. F. Wagner Schlesinger has recently resigned his position as Director of the Fels Planetarium, in Philadelphia, to become Director of the Adler Planetarium in Chicago. Dr. Roy K. Marshall will succeed Mr. Schlesinger as Director of the Fels Planetarium. He will also be an associate director of the Franklin Institute. Readers of the Journal will be interested to note that Dr. Marshall has for some years been an enthusiastic member of our R.A.S.C.

F.S.H.

MEETINGS OF THE SOCIETY

ANNUAL AT-HOME

The Annual At-Home of the Society was held in the Physics Building on Friday evening, January 19th, Dr. A. Vibert Douglas, President, in the chair.

Dr. Douglas welcomed those present, the attendance being in the neighbourhood of 200. After thanking the members for their support and co-operation during her term of office, Dr. Douglas announced that the General Council had chosen for Honorary Membership Sir Arthur Stanley Eddington, O.M., M.A., Sc.D., LL.D., F.R.S., Plumian Professor of Astronomy in the University of Cambridge, England; and Walter Sydney Adams, A.M., Sc.D., LL.D., Director of Mount Wilson Observatory, California. News of Sir A. S. Eddington's death was received shortly after the General Council's action. As a tribute to Sir Arthur, the audience stood in silence for a minute.

Mr. E. J. A. Kennedy, General Secretary, reported that the membership of the Society throughout Canada now numbered 1,221, and that during the year a Centre had been formed in Windsor, Ontario. He then read the results of the recent election of Officers for 1945 (see the Minutes of the Annual Meeting for the names of the Officers and Members of General Council). Dr. A. E. Johns, the new President, was then introduced and took charge of the meeting. After thanking the Society for the honour which had been conferred upon him, Dr. Johns called on Dr. Douglas to give the retiring President's address, the subject being "Astronomy, Physics and Philosophy." The report of this address will be published in the JOURNAL. The thanks of the audience were conveyed to Dr. Douglas and Dr. Johns, after which this part of the meeting was adjourned.

Following the foregoing proceedings, a demonstration of the Electron Microscope was given by Professor Ellis, after which a social hour was spent and refreshments served.

H. W. BARKER, *Recorder.*

AT MONTREAL

October 22, 1944—The twenty-sixth annual meeting of the Montreal Centre was held on the above date in the Macdonald Physics Building, McGill University. Reports of the year's activities were presented by the Secretary, the Treasurer, the Librarian and the Chairman of the Telescope Committee. Following the business period the speaker of the evening, Dr. C. W. Gartlein of Cornell University, Ithaca, N.Y., was introduced. Dr. Gartlein, who is director of the programme of aurora research sponsored by the National Geographic Scociety and Cornell University, spoke on "The Aurora and Geomagnetism," a subject of widespread interest and of particular appeal to the auroral observation group of the Montreal Centre.

In introducing his subject, Dr. Gartlein said that to understand the aurora an appreciation of its vastness and a realization that it is a three-dimensional phenomenon are essential. He stressed the importance of thinking of it in the correct terms and, with the use of slides, described the twelve forms, which consist of three distinct types, the diffuse forms, the homogeneous forms and

those with ray structure. By the comparison of photographs taken at the same instant at points sufficiently far apart, the parallax of the aurora can be measured, and from this parallax shift and the baseline can be derived the height and distance. The usual height of the lower border is 100 kilometers although an occasional aurora has come as low as 60 kilometers. The top of the aurora may be as high as 1000 kilometers and this great height allows it to be seen over great distances.

It is of interest to the observer to know that while displays do not always follow the same sequence it has been found that the various forms cannot appear in just any sequence. When a display of considerable activity quiets down to diffuse patches it seems necessary for a new arc to form before exciting patterns again appear. Special attention should be paid to the exact moment when an arc bursts into rays for it has been found that the earth's magnetic field changes within a minute of the appearance of rays. Observations at one minute intervals are of value during the period when rays are forming.

Dr. Gartlein spoke at some length of the correlation between the aurora and magnetic activity, illustrating graphically various tendencies by means of slides. Reference to statistics accumulated from observations made in the State of New York over a period of forty years shows that the aurora occurs twice as frequently near the equinoctial months as it does near the solstices. Magnetic storms vary in frequency in much the same manner. One remarkable tendency in magnetic storms is their recurrence after an interval of twenty-seven days, and this 27-day recurrence tendency is known for the aurora. It is to be noted that twenty-seven days is about the period of rotation of the lower sunspot latitudes as seen from the earth. Not all magnetic storms or auroral displays show this recurrence tendency. The biggest magnetic disturbances often are not members of such sequences and aurora displays usually occur in groups on successive nights. It can be said, then, that if an aurora is seen on one night there will quite probably be a display the following evening and the next most probable evening is the twenty-seventh from that date.

The collection of auroral data is an important problem. Much work lies ahead both in the field of observation and in the analysis of accumulated data. While so far no instruments have been devised to supplant visual observations, special equipment is required for part of the aurora study. Dr. Gartlein described in detail the equipment at Cornell. This includes a specially constructed camera with an F/2 lens of 45 mm. focus, arranged to take six pictures on a 9×12 cm. negative and with devices to record the data applying to each exposure; a visual photometer; a movie camera with F/1.5 lens, 15 mm. focus, arranged to take pictures at half minute intervals; a precision spectrograph with adjustable slit collimator, two prisms of 4″ face and a 4″ focus camera lens of F/1.65 aperture; a photoelectric recorder and two patrol spectrographs.

In conclusion Dr. Gartlein showed a sequence of fine photographs of the great September display of 1941. Mr. E. Russell Paterson then moved a vote of thanks to the speaker on behalf of the members and friends present.

ISABEL K. WILLIAMSON, *Recording Secretary.*

November 16, 1944—Dr. Ernest A. Hodgson, Seismologist of the Department of Mines and Resources, when addressing a meeting of the Montreal Centre on the subject of "Earthquakes," described exactly what happens when the instruments at Ottawa record an earthquake and he is sent out into the field to locate the epicentre, the point on the earth's surface directly above the focus of the earthquake.

Canada has had only three large earthquakes since the year 1870, said Dr. Hodgson. Of these the earthquake of 1925 in the vicinity of Murray Bay and the South Shore was the most severe. Next in intensity comes the Timiskaming earthquake of 1935, while the recent one near Cornwall in September 1944 ranks third.

The seismograph indicates the general area of the earthquake but the seismologist to locate the epicentre has to track down every bit of evidence that is reported. In Canada large landslides or faults as the result of earthquakes are practically unknown and it is difficult, therefore, to discover evidence in the unpopulated areas, but damage to chimneys, tombstones, piles of pulp wood, even stacks of soup bowls on the shelf in a boarding house, all tell a story which the seismologist interprets. For instance, in the 1925 earthquake the fact that icicles were still hanging in the city of Quebec was significant. To take another example, in the Cornwall earthquake tombstones on the north shore of the river had turned counter-clockwise whereas tombstones on the south shore had turned an almost equal degree in a clockwise direction, and "up-bumped" chimneys in the vicinity of Massena indicated that the epicentre was not far distant. One important thing to be kept in mind when weighing all the evidence is that more damage is done to buildings on alluvial soil than those erected on solid ground, and the extent of the damage is not always an indication of the location of the epicentre.

People who have experienced an earthquake are always anxious to know what the possibilities are of another occurring in that area in the near future. Dr. Hodgson's reply is that in all probability tremors will be felt again within the next few days, weeks or even months but, judging by accumulated data, none of them will equal in intensity the first shock. Subsequent tremors, however, may be sufficient to cause unstable structures to collapse and it is wise to repair at the earliest opportunity damage done by the first shock.

As Mr. Henry F. Hall said in thanking the speaker at the close of the lecture, not only is Dr. Hodgson eminently qualified to speak on this subject, but he also possesses a keen sense of humour and an ardent enthusiasm for his work, a combination of qualifications not often found in a speaker.

ISABEL K. WILLIAMSON, *Recording Secretary.*

SERIES OF POPULAR LECTURES 1944-45 SEASON

When planning the programme at the beginning of the season, the Council of the Montreal Centre decided to have another series of popular lectures with one lecture a month from November to May and, in addition, another lecture

each month of a more advanced nature so that the programme would include something of interest to all members of the Centre.

The popular lectures were presented in such a manner that no previous study of astronomy was necessary and the series was widely advertised to the public by means of circulars distributed to large business concerns as well as by the usual newspaper notices. The results of the advertising were very satisfactory. The lectures were well attended and numerous applications for membership in the Society were received. While, admittedly, a certain percentage of the members thus obtained drop out at the end of the series, the large majority renew their membership the following year and it has been learned from past experience that many of the new members become actively engaged in the various fields of observation open to the amateur and that the new blood brought into the Centre does much to stimulate the interest of the older members.

The introductory lecture in the series, "The Universe as a Whole," was given by Mr. Henry F. Hall, Vice-President of the Montreal Centre, on 9th November, 1944. Mr. Hall first described the small corner of the universe that is most familiar to all of us, the Earth and its satellite, the Moon, and then proceeded to give his audience some idea of the relative sizes and distances of the Sun and its family of planets and comets which comprise the Solar System. He then described in a general way the Milky Way and the other galactic systems, using comparisons to enable his listeners to have some conception of the vastness of the universe, and illustrating his lecture with a number of excellent slides.

On December 14th, Mr. E. Russell Paterson gave the second lecture in the series, "The Solar System." He succeeded in packing into one brief hour a fairly detailed description of the Sun and planets, emphasizing the outstanding characteristics of each in such an entertaining manner that his audience felt well acquainted with the individual members of the solar system by the close of the lecture.

For the January meeting, Mr. Francis P. Morgan was confronted with the difficult task of presenting in popular form a lecture on "The Galactic Systems," a task which he accomplished admirably, resisting the temptation to delve more deeply into the problems which the galaxies present, and confining himself to a description of the various types of galaxies, their distribution through space, and the methods by which their sizes and distances are estimated.

A report of the remaining lectures in the series will follow.

ISABEL K. WILLIAMSON, *Recording Secretary.*

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1890-1945

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For many years the Toronto organization existed alone, but now the Society is national in extent, having active Centres in Montreal and Quebec, P.Q.; Ottawa, Toronto, Hamilton, London and Windsor, Ontario; Winnipeg, Man.; Edmonton, Alta.; Vancouver and Victoria, B.C. As well as about 950 members of these Canadian Centres, there are over 200 members not attached to any Centre, mostly resident in other nations, while some 300 additional institutions or persons are on the regular mailing list for our publications.

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